Electronic Version

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Claims

[c1] 1. A method to reduce vibration in a turbine-generator comprising:

measuring a magnitude of radial vibration of a turbine shaft with at least one vibration sensor configured to generate a vibration signal indicative of vibration frequency;

measuring a generator power output with a power output sensor configured to generate a generator power output signal;

detecting vibration frequencies in a rough load zone range;

engaging an air injection means when a magnitude of radial vibration detected in said rough load zone range is above a predetermined threshold;

storing a generator power output level as a reference level when said engaging said air injection means; and

disengaging said air injection means when one of said measured generator power output exceeds a predetermined level and said measured generator power output differs from said reference level by a predetermined amount.

[c2] 2.The method of claim 1 further comprising: filtering said vibration signal to determine said magnitude of vibration in said rough load zone range.

[c3] 3.The method of claim 1 further comprising: latching engagement of said air injection means to said generator power output.

[c4] 4. The method of claim 1, wherein said air injection means includes regulating means for regulating the injection of air into the turbine.

[c5] 5.The method of claim 4, wherein said air injection means includes a compressor.

[c6] 6.The method of claim 1, wherein said predetermined amount is one of the same and different for generator increasing load and decreasing load.

[c7] 7.The method of claim 1, wherein if vibration increases causing said air injection means to engage after said air injection means has been disengaged, a new generator power output reference level is stored.

[c8] 8.The method of claim 1, wherein said at least one vibration sensor includes two vibration sensors disposed substantially orthogonal to one another relative to an axis of said turbine shaft to measure vibration in multi-

ple planes.

[c9] 9.The method of claim 1, wherein said vibration sensor includes an eddy current proximity probe proximate a turbine guide bearing.

[c10] 10.The method of claim 1, wherein a relay is closed to engage said air injection means, said relay remaining latched even though said magnitude of radial vibration is below said predetermined threshold to avoid cycling said air injection means on and off.

[c11] 11.The method of claim 1, wherein the rough load zone range is between about 0.15 to about 0.35 times an operating speed of the generator.

[c12] 12A system to reduce vibration in a turbine-generator comprising:

at least one vibration sensor measuring a magnitude of radial vibration of a turbine shaft, said at least one vibration sensor configured to generate a vibration signal indicative of vibration frequency and said magnitude;

a power output sensor measuring a generator power output, said power output sensor configured to generate a generator power output signal;

a monitoring system configured to receive said vibration signal and said generator power output signal;

a computer in operable communication with said monitoring system, said computer configured to detect vibration frequencies in a rough load zone range; and

an air injection means configured to engage when a magnitude of radial vibration detected in said rough load zone range is above a predetermined threshold, wherein a generator power output level is stored in said computer as a reference level when said engaging said air injection means, said air injection means being disengaged when one of said measured generator power output exceeds a predetermined level and said measured generator power output differs from said reference level by a predetermined amount.

[c13] 13.The system of claim 12, wherein said vibration signal is filtered to determine said magnitude of vibration in said rough load zone range.

[c14] 14.The system of claim 12, wherein engagement of said air injection means is latched to said generator power output.

[c15] 15. The system of claim 12, wherein said air injection means includes regulating means for regulating the injection of air into the turbine.

[c16] 16.The system of claim 15, wherein said air injection

means includes a compressor.

[c17] 17.The system of claim 12, wherein said predetermined amount is one of the same and different for generator increasing load and decreasing load.

[c18] 18.The system of claim 12, wherein a new generator power output reference level is stored if vibration increases causing said air injection means to engage after said air injection means has been disengaged.

[c19] 19.The system of claim 12, wherein said at least one vibration sensor includes two vibration sensors disposed substantially orthogonal to one another relative to an axis of said turbine shaft to measure vibration in multiple planes.

[c20] 20.The system of claim 12, wherein said vibration sensor includes an eddy current proximity probe proximate a turbine guide bearing.

[c21] 21.The system of claim 12 further comprising a relay configured to close to engage said air injection means, said relay remaining latched even though said magnitude of radial vibration is below said predetermined threshold to avoid cycling said air injection means on and off.

[c22] 22.The system of claim 12, wherein the rough load zone

range is between about 0.15 to about 0.35 times an operating speed of the generator.